



# The 1<sup>st</sup> Conference on Women in Physics- Zimbabwe

24-26 JULY 2024

Bindura University of Science Education

**“WHEN WOMEN SUPPORT EACH OTHER, INCREDIBLE THINGS HAPPEN”**

**Programme and book of abstracts**





## Overview

The inaugural Women in Physics in Zimbabwe Conference (WiPZC) 2024 is an event that seeks to celebrate, empower, and support women in physics, promoting gender equality and excellence in the field. This three-day hybrid conference will unite physicists from academia, industry, and government, providing a platform for:

- Showcasing cutting-edge research and innovations
- Sharing professional experiences and insights
- Fostering a supportive community and networking opportunities

By offering a flexible and inclusive hybrid format, WiPZC 2024 aims to reach a broader audience, ensuring that women in physics from diverse backgrounds can participate, connect, and thrive. Join us in shaping a more inclusive and vibrant physics community in Zimbabwe.

## Keynote Speakers

**Prof. M. Diale**, Professor of Physics and South African Research Chair (SARCHI) in clean and green energy in the Department of Physics at the University of Pretoria

**Dr. K Shingange**, distinguished scientist at Mintek in South Africa and serves as the chairperson of Women in Physics in South Africa (WiPiSA).

## Sponsors

We are grateful to our sponsors for their generous support:

- The **International Union of Pure and Applied Physics (IUPAP)**
- **Dr James Makamba** (Businessman, Philanthropist, Broadcaster, Politician)





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Dear esteemed delegates, speakers, and guests,

On behalf of the organizing committee, it is our pleasure to welcome you to the 1<sup>st</sup> Conference on Women in Physics-Zimbabwe! We are thrilled to bring together a diverse group of professionals, researchers, and students from around the world to share ideas, experiences, and innovations in Physics.

We have crafted a complete program featuring keynote speeches, plenary talks, and networking opportunities to foster collaboration and knowledge sharing. Our esteemed speakers and presenters are renowned experts in their fields, and we are confident that their insights will inspire and enlighten you.

During your stay, we hope you will take advantage of the opportunities to connect with colleagues, make new friends, and explore Bindura.

Thank you for joining us on this exciting journey. We look forward to a productive and enjoyable conference!

Best regards,

***WiPZC 2024 Organizing Committee***





## **General Information**

**Campus Security:** 0772922636

**Taxis:** Sharlmart Taxis (0773727672/ 0773799506)

Mr Mhene (0776542968)

## **Local Organizing Committee members:**

Prof C Zvidzai: *Acting Dean of Science and Engineering Faculty*

Dr L Sakala: *Acting Deputy Dean of Science and Engineering Faculty*

Dr C Shonhiwa: *Chairperson of Engineering and Physics Department*

Dr. J Masanganise: *Lecturer in the Engineering and Physics Department*

Dr. H Nyakoty: *Lecturer in the Engineering and Physics Department*

Dr. H T Danga: *Lecturer in the Engineering and Physics Department*

Mr S Chiminya: *Lab Technician in the Engineering and Physics Department*

## **Registration Desk**

The registration desk will be open during the following hours:

Day 2: 08:30 - 16:00

Day 3: 08:30 - 10:00

Please visit the registration desk to collect your conference materials, including your name tag and other relevant information.





## Conference Schedule

The conference will feature a variety of sessions, including keynote speeches, plenary talks, oral and poster presentations. Here is a brief overview of the schedule:

Zimbabwean time GMT +2	08:30	09:30	10:00	10:30	11:00	12:00	13:00	14:00	15:00	16:30	17:00	18:00	19:00	20:00
<b>Day 1</b> Wednesday 24 July					Arrival of conference delegates						Welcome Reception & Launching Ceremony			
<b>Day 2</b> Thursday 25 July	Registration	Keynote Talk 1 via Zoom		Tea Break	Plenary 1, Special Presentation & Oral Presentations		Lunch	Plenary 2 via Zoom, Oral Presentations & Poster session						
<b>Day 3</b> Friday 26 July	Registration	Keynote Talk 2 via Zoom		Tea Break	Plenary 3, Plenary 4 & Group Photo		Lunch							

For the detailed schedule, please refer to the conference programme.



## Conference Programme

### Day 1: July 24

17:30 - Official Opening & Launching Ceremony, FSE, F01  
19:00 Opening Prayer, Rev. Maforo

Welcome from Prof. E Mwenje, the VC of the Bindura University of Science Education (BUSE)

Prof. C Zvidzai, Dean of the Faculty of Science and Engineering

Dr C Shonhiwa, Zimbabwean Team Leader for the Women in Physics in Zimbabwe, Chairperson of the Engineering and Physics Department at BUSE.

Remarks by invited guest of honour: *Provincial Education Director: Mashonaland Central Province Dr. T Mangwiro*

19:00 - Launching Ceremony and Dinner  
20:00

### Day 2: 25 July

9:00 - Opening remarks: FSE Multipurpose Hall  
9:30 Mrs U. Chipunza



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9:30 -  
10:20

Keynote Talk 1, FSE Multipurpose Hall, Prof M. Diale University of Pretoria (UP), South Africa, **Advancing science and innovation through women in physics support.**

*Chair: Dr. T Chikrerema*

10:30 -  
11:00

Tea

11:00 -  
11:45

Plenary Talk 1, FSE Multipurpose Hall, Ms S. Dube, STEM Lady, Elevate Trust, **Motivation Talk with STEMLady**

*Chair: Dr C Shonhiwa*

12:00 -  
13:00

Dr. T Mangwiro, PED, special presentation (10 minutes)

*Chair: Prof Mavhura*

Oral Presentations (first half)

*Chair: Mr. T Manyeredzi*

13:00 -  
14:00

Lunch







14:00 - Plenary Talk 1, Prof. M. Steinitz, St. Francis Xavier University, Nova Scotia, Canada, **Some Observations on Ethical Problems and Conundra for Scientists**  
14:45

*Chair: Dr H. Nyakoty*

15:00 - Oral presentations (second half)  
16:30 Poster presentations

*Chair: Dr H.T. Danga*

### Day 3: 26 July

9:30 - Keynote Talk 2, FSE Multipurpose Hall, Dr K Shingange, Mintek, Johannesburg, South Africa, **The Transformative Power of Women Supporting Women in Physics: A Journey of Mentorship, Collaboration, and Success**  
10:20

*Chair: Dr L.Sakala*

10:30 - Tea  
11:00





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11:00 –  
11:45

Plenary Talk 3, FSE Multipurpose Hall, Dr E. Matandirotya, University of Zimbabwe (UZ), **Unlocking potential for development through space sciences and technology**

*Chair:* Dr J Masanganise

11:50 –  
12:35

Plenary Talk 4, FSE Multipurpose Hall, Dr N. Mgocheki, Bindura University of Science Education (BUSE), **Applications of entobiopolymers in physics**

*Chair:* Dr Mudzamiri

12:45 -  
13:00

Closing remarks: *Prof. C Denhere*

Group Photo

13:00 -  
14:00

Lunch





# Invited Speakers





**Prof. M Diale**

University of Pretoria (UP), South Africa

**Title of talk: *Advancing science and innovation through women in physics support.***

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Prof Mmantsae Diale is a device scientist, whose main research interests lie in exploring physical and chemical means to control the electronic and optical properties of materials. She has a keen interest in solar energy conversion with a desire to see a life off the grid with photovoltaics (PV) and artificial photosynthesis (AP), She is currently the South African Research Chair (SARCHI) in clean and green energy in the Department of Physics at the University of Pretoria. Prof. Diale currently serves as an expert and leader in several national and international committees, boards and initiatives for renewable energy solutions and related matters in climate change. Prof. Diale is active in finding ways to use scientific knowledge as a contribution towards addressing the world energy crisis and making it more accessible to greater mankind.



**Dr. Katekani Shingange**

Mintek, South Africa

**Title of talk: "The Transformative Power of Women Supporting Women in Physics: A Journey of Mentorship, Collaboration, and Success"**

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Dr. Shingange is a notable emerging researcher in physics, boasting over 20 peer-reviewed articles and an impressive H-index of 13. Her contributions extend beyond research; she actively participates in science communication workshops, mentors postgraduate students and junior researchers, and engages in job shadowing programs for high school learners. Her dedication to knowledge transfer and skill development has made her a significant figure in her field. Recognition for Dr. Shingange's outstanding contributions has come in various forms. Notably, she received the South African Women in Science Award in 2019 from the Department of Science and Innovation for her remarkable contributions to the field of Physics. In 2020, she was honored with the CSIR Best Doctoral Award for excellence in her PhD studies. Additionally, she was acknowledged as an inspirational woman in STEM by #InspiringFiftySA in 2021, distinguishing her role as a motivator for young girls and women in STEM. Dr. Shingange serves as the chairperson of Women in Physics in South Africa (WiPiSA), championing the cause of women in physics and advocating for increased female participation in physics-related careers.

Her commitment to empowering women in STEM is highlighted by her involvement in various activities aimed at attracting and nurturing female talent in the field. In 2023, Dr. Shingange was recognized as one of the 200 Mail & Guardian Young South Africans in the Technology and Innovation category, further solidifying her position as a trailblazer in her field. She also had the prestigious opportunity to attend the Lindau Laureates Meeting in 2019, dedicated to Physics, an event that brings together young scientists across the globe with Nobel laureates, showcasing her international standing and contributions to physics. In addition, Dr. Shingange was a finalist for the 2023/2024 NSTF-South32 Awards under the category TW Kambule-NSTF Award: Emerging Researcher and a semifinalist for the 2024 TransUnion Rising Star Awards under the Mining and Minerals sector.



**Prof. Michael Steinitz**

St. Francis Xavier University, Antigonish,  
Nova Scotia Canada

**Title of talk: *Some Observations on Ethical Problems and Conundra for Scientists***

Michael is Emeritus Professor of Physics at St. Francis Xavier University in Nova Scotia, He is a past-president of the Canadian Association of Physicists and for three years was chairman of the board of directors of the Canadian Institute for Photonic Innovations. He serves on Commission 13 (Physics for Development) of IUPAP (the International Union for Pure and Applied Physics). His research has been largely on incommensurate structures in metals, using neutron diffraction and dilatometric methods. He has represented Canada at International Conferences on Women in Physics in Brazil, South Africa and Canada.



**Ms S. Dube, The STEMLady**  
Elevate Trust

**Title of Talk: Motivation Talk with STEMLady**

Sicelo Dube known as the STEMLady is one of Africa's award winning and inspirational scientists and entrepreneur. Recently named UNESCO's Girl Empowerment Champion under the L'Oreal Foundation young talents 2023, Sicelo has also been recognized by the US Embassy in Zimbabwe as an outstanding Mandela Washington Fellow. Sicelo is founder of LEC Biotech, a company she started at 23 to grow Scientists for the future generation through building and equipping science laboratories and spearheading capacity building for science educators, especially in rural schools. Her passion for a practical approach to STEM has influenced her teaching career, focusing on encouraging young people to explore new and innovative ways to harness the power of STEM to make a difference in their communities under the #SciencePays initiative. The STEM Lady champions youth development and is passionate about empowering

the girl child, an approach that has led her to establish “Elevate Trust,” a youth development non-profit organization whose main initiatives include; innovators hub clubs and STEM Fem Network, which boosts mentoring girls to take up STEM careers contributing to gender parity in the STEM workforce. She is a leadership coach and motivational speaker for girls’ and women’s empowerment programs. Ms. Dube is an Innovative Young Entrepreneur on several boards, including the Harare Institute of Technology Faculty of Industrial Manufacturing and Engineering, STEM Matters International and Monochrome Mining. She is also one of the African regional leaders for Women in Technology International. The STEM Lady believes that all we need to change the face of Africa are young Scientists driven to create the change they want to see in their communities through innovation and entrepreneurship



**Dr E. Matandirotya,**  
University of Zimbabwe (UZ),

**Title of talk: *Unlocking potential for development through space sciences and technology***

Dr. Electdom Matandirotya is a Chief Scientist for the Space Science Department at Zimbabwe National Geospatial and Space Agency (ZINGSA). She holds the following academic degrees and other several professional certificates:

- Deng (Electrical Engineering) from Cape Peninsula University of Technology (In collaboration with the South African Space agency)
- MTech (Electrical Engineering) and MSc (Electrical and Electronic systems) awarded through the Cape Peninsula University and Technology in collaboration with the French South African Institute of Technology
- BSc Hons in Applied Physics from the National University of Science and Technology, Zimbabwe
- She holds several certificates in leadership and technical domains.

Her roles include defining and leading space science research in line with the space agency strategic goals. She is an active participant in national space awareness programmes that aim to help young learners understand space concepts and appreciate the significant roles played by the space industry. She is also a senior lecturer at the University of Zimbabwe, in the Space Science and Applied Physics department, offering courses and research supervision in the space science and engineering domain. Her research interests are in Space Weather Hazards, Air quality monitoring and Satellite subsystem designs. She is very passionate about helping the girl child realize her full potential and always avails herself for mentorship and career guidance.



**Dr N. Mgocheki**  
Bindura University of Science Education  
(BUSE)

**Title of talk: *Applications of entobiopolymers in physics***

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Dr Nyembezi Mgocheki is currently a senior lecture at Bindura University of Science, Biological Sciences Department. She holds a PhD Entomology from Stellenbosch University. Currently she is working on mass rearing/breeding of beneficial insects including black soldier fly. Dr Mgocheki is currently involved in isolation and characterisation of biopolymers from black soldier flies, namely chitin and its derivative chitosan. These have applications in mitigating climate change impacts in agriculture, biomedicine, packaging and physics. She is also currently involved in community projects aimed at developing novel pest management strategies using biopesticides and biological control. She has initiated and spearheaded creation of agricultural projects in communities aimed at poverty alleviation using smart technologies.



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# Book of Abstracts







## Invited Speakers

### **Advancing science and innovation through women in physics support**

*M. Diale*

*University of Pretoria, Pretoria, South Africa*

Science plays a pivotal role in innovation, economic emancipation, unemployment and poverty reduction. While we face issues such as poverty and hunger, the training of women in physics plays a pivotal role in addressing societal issues. Physics is the backbone of innovation because it is the nerve of thinking, leading to employment in every sector of the economy, by employing physics graduate. As compared to other sciences, physics education considers the use of mathematics and chemistry in the production of new technology and gadgets. It has been proved that supporting women in physics resulted in the increase of qualified teachers, thus we produced auxiliary professionals like nurses, doctors, and engineers, because physics is a thinking skill. Women in Physics project is an IUPAP initiative, launched in 2002 at UNESCO headquarters, in France, it has travelled a long way, and the results are evident. As we launch the conference on women in physics in Zimbabwe, we hope to create a path for young women to take physics in schools and beyond, to show that Physics can solve problems facing societies like climate change.





## **Applications of entobiopolymers in physics**

*N. Mgocheki*

*Bindura University of Science Education, Bindura, Zimbabwe*

Insect biopolymers, such as chitin, chitosan and silk, possess unique structural and functional properties that have opened new frontiers in various fields of physics. These naturally derived materials exhibit exceptional mechanical strength, elasticity, biocompatibility, and biodegradability, making them highly suitable for innovative applications in material science, nanotechnology, optics, bioelectronics and energy storage. In material science, chitin and chitosan are utilised to develop lightweight, strong composites and coatings, while silk is employed in creating flexible and durable materials for medical devices and textiles. Nanotechnology benefits from the nanoscale processing of these biopolymers, enabling advancements in drug delivery systems, filtration and catalysis through nanofibres and nanoparticles. In the realm of optics, the photonic crystal structures inspired by insect exoskeletons and wings are used to create advanced photonic circuits and sensors. Bioelectronics leverages the conductive properties of modified chitosan and the robust scaffolding of silk to enhance the performance of flexible circuits, biosensors and biofuel cells. Additionally, the study of insect biomechanics informs the development of bio-inspired designs for applications in aerospace and structural engineering. This abstract highlights the diverse and impactful ways in which insect biopolymers are revolutionizing various domains within physics, paving the way for sustainable and cutting-edge technological solutions.





## **The Transformative Power of Women Supporting Women in Physics: A Journey of Mentorship, Collaboration, and Success"**

*Katekani Shingange*

*DSI/Mintek Nanotechnology Innovation Centre, Randburg, Johannesburg 2125, South Africa*

With a distinguished career marked by significant achievements and contributions to the field, Dr. Shingange's story serves as a testament to the power of community and support among women in STEM. In her presentation, Dr. Shingange will reflect on her personal and professional journey, highlighting the pivotal moments and challenges she has encountered. She will discuss how mentorship, collaboration, and the support of fellow women in Physics have been instrumental in her success. By sharing her experiences, Dr. Shingange aims to inspire and empower other women in the field to pursue their goals with confidence and determination.

Dr. Shingange will also explore the impact of initiatives like the Women in Physics in South Africa (WiPiSA), a forum under the South African Institution of Physics (SAIP), which has played a crucial role in fostering a supportive and collaborative environment. Through mentorship programs, departmental lunches, membership sign-ups, and skill development webinars, WiPiSA promotes community building, professional growth, and leadership opportunities for women in Physics.

This presentation will highlight the transformative power of women supporting each other, showcasing how such support leads to increased participation, innovation, and success in the discipline. Dr. Shingange's inspiring narrative will highlight the importance of solidarity and collaboration, encouraging attendees to embrace and contribute to a culture of mutual empowerment in the field of Physics.





## Some Observations on Ethical Problems and Conundra for Scientists

*M. Steinitz*

*St. Francis Xavier University, Antigonish, Nova Scotia Canada*

In our current era, marked by population growth, consumption demands, and climate change, scientists face numerous ethical challenges. Every discovery can have both beneficial and harmful consequences. For example, nuclear fission has given us both the atomic bomb, which poses a threat to human existence, and nuclear power, which could help mitigate catastrophic climate change. A controversy in the late 1930s involved Nobel laureate Peter J. W. Debye, who signed a letter with "Heil Hitler" as president of the German Physical Society. Despite this, he later emigrated to the US, where he helped save Jewish scientists. This case illustrates the complex ethical decisions faced under oppressive regimes. In conclusion, the ethical landscape in science is complex, with each discovery and decision carrying the potential for both positive and negative impacts. Scientists must navigate these challenges with care and responsibility.





# Contributed Papers





## Renewable (Green) Energy with Applications In Rural Areas Developing A Mini-Scale Biogas-Electricity Project For Manzununu Rural Community

*Chibonga B<sup>1,2</sup>. and Mavata M<sup>1</sup>*

<sup>1</sup>*University of Zimbabwe, Zimbabwe*

<sup>4</sup>*Midlands State University, Zimbabwe*

The research study was carried out to cost and design a mini-biogas-electric-plant for Manzununu secondary school which is situated in the remote mountainous area of Vumba in Manicaland Province. The school with an estimated population of 900-1000 learners is not connected to the national electricity grid. A model survey was conducted to decide the quantity of feedstock and energy demand for the whole school was calculated and it was found to be 1 172 kWh per day. The biogas produces for the feedstock at the school were estimated. The total yield that could be obtained from the feedstock was 257m<sup>3</sup> per day. The bio digester volume for the feedstock was also estimated and the total material requirements for the digester was also determined. Biodigester sizing and costing was done for the school. Inclusively, potential biogas conversion to electricity was done as a single centralised mini-biogas-electric-plant. This was then followed by a cost benefit analysis of commissioning the biogas technology. From the observed results there was a surplus of about 421 kWh/day at maximum production and 29 kWh at minimum production which can be directed to other developmental projects. The results suggested that the proposed project was viable, and it was concluded that the school is capable of producing enough biogas from its feedstock to support a viable project

### References:

1. "Biogas Technology: Towards Sustainable Development" by B. T. Nijaguna..
2. Ketuama CT, Roubik H. Economic viability and factors affecting farmers' willingness to pay for adopting small-scale biogas plants in rural areas of Cameroon. *Renewable Energy*. 2024 Jun 28;120895..





## Empowering Women in Physics: Breaking Barriers and Encouraging Inclusion

*Chigavo P. and Mabota S.*

*Midlands State University, Gweru, Zimbabwe*

Physics is among the worst of the physical sciences in terms of representation of women in many countries [1]. Despite significant advancements in gender equality, women continue to face various barriers and biases that hinder their progress and limit their participation in physics related fields. This abstract highlight the importance of addressing these issues and promoting the inclusion of women in physics. It will also review the current state of women in physics specifically at Midlands State University and emphasize the disparities in representation at various career stages, from undergraduate education to faculty positions and leadership roles. Additionally, it explores the factors contributing to these disparities, including implicit biases, stereotype threat, lack of role models and work-life balance challenges. To address these gaps, this abstract proposes utilizing nationwide data on first-time, full-time college students to [2] document national trends in plans to major in physics among women entering college [3] document the career aspirations of women who intend to major in physics. Moreover, it proposes a multifaceted approach by highlighting the significance of early interventions, such as fostering interest in science among young girls, providing mentorship programs and implementing bias-aware admissions processes. In conclusion, this paper emphasizes the urgent need to empower women to fully participate and excel in physics-related fields as this not only benefits women individually but also contribute to scientific progress and societal advancement as a whole.

### References:

1. Nature. Data on women in physics. *Nat Rev Phys* (2019) 1:297. doi:10.1038/s42254-019-0061-3
2. Gender equality: Strengthening the physics enterprises in universities and national laboratories, American Physics Society Report, 2007, <https://www.aps.org/programs/women/workshops/gender-equity/upload/genderequity.pdf>.
3. S. White and C. Tesfaye, *Female Students in High School Physics* (American Institute of Physics, College Park, MD, 2011).





## Women and Girls in Physics Education

*Chipendo, Tracy,*

*St Anne's High School, Wedza, Zimbabwe.*

As a former physics student, I experienced firsthand the underrepresentation of women in physics. Despite making up a significant portion of O-level physics classes, girls tend to drop out as they progress to A-level, leading to a predominantly male field. This trend is perpetuated by societal beliefs that physics is a "male" occupation, causing women to fear failure and underperform. Even female students prefer male teachers, making it challenging for female physicists to succeed in education. My presentation aims to explore the challenges women face in physics education, highlight the importance and role of women in STEM, and discuss ways to promote gender balance in these fields. Despite facing obstacles, women are making significant contributions to STEM fields, proving that they can excel in these areas with the right support and encouragement.

### References:

1. The Inter-academy Partnership 2016 Women for science: inclusion and participation in academies of science (Trieste: IAP)
2. Women in Physics: The IUPAP Int. Conf. on Women in Physics 2002 vol. 628 ed B K Hartline and D Li (College Park: American Institute of Physics)
3. Women in Physics: 2nd IUPAP Int. Conf. on Women in Physics 2005 vol. 795 ed B K Hartline and A Michelman-Ribeiro (College Park: American Institute of Physics)
4. UNESCO. Cracking the code: girls and women's education in science, technology, engineering and mathematics (STEM) (Geneva: UNESCO)
5. A Global Approach to the Gender gap in mathematical, computing, and natural sciences: how to measure it, how to reduce it?. Available from: <https://gender-gap-in-science.org/>







## Women in Physics in Zimbabwe: Challenges and Triumphs

*Matandirotya Electdom<sup>1</sup>, Shonhiwa Chipo<sup>2</sup>, Moyo Nomathemba, Mufute Patricia, Mabota Shamiso<sup>4</sup> and Danga, Helga Tariro<sup>2</sup>*

<sup>1</sup>*University of Zimbabwe, Harare, Zimbabwe*

<sup>2</sup>*Bindura University of Science Education, Bindura, Zimbabwe*

<sup>3</sup>*National University of Science and Technology, Bulawayo, Zimbabwe.*

<sup>4</sup>*Midlands State University, Gweru, Zimbabwe*

The participation of women in physics in Zimbabwe remains persistently low [1,2]. This report examines the career paths and whereabouts of female physicists who graduated from state universities in Zimbabwe over the past decade. We collected data from five institutions of higher learning that offer degrees in Physics and Physics education, spanning from 2013 to 2023. Our findings shed light on the post-graduation trajectories of these female physicists, providing valuable insights into the challenges and opportunities that have shaped their careers in this male-dominated field.

### References:

1. S. Shambira, "Women in Physics in Zimbabwe," Women in Physics: 2nd IUPAP International Conference on Women in Physics, AIP Conference Proceedings 628, edited by Beverly Karplus Hartline and Dongqi Li (American Institute of Physics, Melville, NY, 2002), <https://aip.scitation.org/doi/10.1063/1.1505353>.
2. H. T. Danga, S.M. Tunhuma, V. E. Gora, J. F. Jena, and A. Chawanda, Women in Physics in Zimbabwe, AIP Conference Proceedings, 2109 (2019).



## Investigation of Biomimetic Coatings on Glassy Carbon and Ti-6Al-4V Substrates: Impact of Varying Surface Preparation Methods

*Dockrat, Unaisa<sup>1</sup>, Malherbe, Johan.B<sup>1</sup>, Ntsoane, Tshepo.P,<sup>2</sup> Thabethe, Thabsile<sup>1</sup>*

<sup>1</sup>*Physics Department, University of Pretoria, Hatfield, South Africa.*

<sup>2</sup>*Physics Department, South African Nuclear Energy Corporation, Pretoria, South Africa.*

Biomimetic coatings, an innovative advancement in biomedical engineering, replicate the intricate mechanisms and superior properties observed in biological systems to enhance the performance, durability, reliability, and biocompatibility of biomedical implants [1][2]. These coatings aim to improve implant integration with the human body, addressing the challenges of traditional coatings like thermally sprayed hydroxyapatite (HAp), which can suffer from inherent residual stress, undesirable thermal products, poor biocompatibility, infection risk, and inadequate tissue integration [2]. By imitating natural biochemical processes, biomimetic coatings with better cellular adhesion, proliferation, and differentiation [3] can be produced. This study explores biomimetic deposition on Ti-6Al-4V (Ti64) and glassy carbon (GC) substrates, pretreated with sandblasting, plasma etching, and polishing, and then immersed in simulated bodily fluid (SBF) for 56 days. The resulting coatings were analyzed using scanning electron microscopy (SEM) for surface morphology, energy-dispersive X-ray spectroscopy (EDS) for elemental analysis, and X-ray diffraction (XRD) to evaluate their structural and compositional properties.

EDS analysis revealed higher Ca and P on coatings deposited on plasma-etched and polished GC substrates, while sandblasted Ti64 substrates showed higher O, Ca, and P. Plasma-etched GC and sandblasted Ti64 apatite coatings resembled thermally sprayed HAp layers on Ti64, indicating similar elemental compositions. Ti64 substrates subjected to polishing and plasma etching had lower element percentages due to pre-treatment. SEM images showed distinct surface morphologies: GC substrates had tightly packed spherical particles creating a rough texture, while sandblasted Ti64 substrates exhibited densely packed spherical clusters and plasma-etched Ti64 samples had small, uneven clusters forming a porous texture. XRD confirmed coatings on polished and plasma-etched GC and the sandblasted and plasma-etched Ti64 as hydroxyapatite with fine grain size. These findings highlight the advantages of biomimetic coatings, which produce no residual stress, enhance surface roughness, introduce functional groups, and promote apatite crystal growth, influencing elemental composition and distribution.

### References

1. Smith, A. M., & Callow, J. A. (2016). Biomimetic Coatings for Biomedical Applications: Advances in Synthesis and Applications. *Journal of Biomedical Materials Research Part A*, 104(6), 1457-1472. doi:10.1002/jbm.a.35781.
2. Zhao, L., Wang, H., Huo, K., Cui, L., Zhang, W., Ni, H., ... & Chu, P. K. (2011). Antibacterial nano-structured titanium for biomedical applications. *Nanomedicine: Nanotechnology, Biology and Medicine*, 7(2), 177-185. doi:10.1016/j.nano.2010.10.004.
3. Wang, X., Li, Y., Wei, J., & de Groot, K. (2002). Development of biomimetic nano-hydroxyapatite/poly(hexamethylene adipamide) composites. *Biomaterials*, 23(24), 4787-4791. doi:10.1016/S0142-9612(02)00207-0.



## **Sizing and Simulation of The Performance of a Solar Water Heating System For Ruya Adventist High School (RAHS)**

*Rumbidzai Muwusha and Chipo Shonhiwa*

*Bindura University of Science Education*

With rising electricity costs and environmental concerns, new technologies are being developed to harness energy from various sources. This study aimed to size and simulate a solar water heating system (SWH) for Ruya Adventist High School (RAHS). Detailed calculations were performed to determine the hot water demand using data from the school. Excel was used to size SWHs for the boarding facilities, kitchen, and staff houses. The System Advisor Model (SAM) was used to simulate the system's performance. RAHS has 350 girls and 280 boys who require hot water daily in their boarding facilities, with hostels located 300 meters apart, necessitating two separate systems. The school also has 60 staff households, each averaging five people, requiring individual SWHs. Suitable hot water storage tanks were identified for both staff residences and student hostels, with a total collector array needed to provide adequate heating. The SWHs are expected to save 1,982 kWh, 42,528 kWh, and 36.415 kWh of electrical energy for each staff house, girls' hostel, boys' hostel, and kitchen, respectively. The systems achieved a minimum solar fraction of 0.54. The performance was lowest during winter when auxiliary heating was most needed due to reduced solar irradiance. Increasing the collector array area boosts grid energy savings. The study indicates that installing SWHs at RAHS can significantly reduce electricity consumption from the grid, creating a 200 kW virtual power plant. The research recommends further economic and financial appraisals to determine the project's viability, enabling the school to make an informed decision on the SWH installation.

### **References:**

1. Fadzlin WA, Hasanuzzaman M, Rahim NA, Amin N, Said Z. Global challenges of current building-integrated solar water heating technologies and its prospects: a comprehensive review. *Energies*. 2022 Jul 14;15(14):5125.
2. Huang J, Fan J, Furbo S, Li Q. A policy study on the mandatory installation of solar water heating systems—Lessons from the experience in China. *Solar Energy*. 2020 Aug 1;206:614-27.



## Assessing Biomimetic Coating on Graphite

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The use of bone implant devices has significantly increased and is projected to rise further from 2028 to 2060 due to the growing number of individuals with skeletal and heel diseases requiring corrective interventions [1],[2]. Endoprosthetic implants are popular for addressing joint wear and tear from accidents and sports injuries [3]. Despite advancements, challenges such as corrosion, infection, nerve damage, and coating issues persist [4]. Traditional thermal spraying methods for biomaterial coatings face challenges like high residual stress and adhesion issues. This study explores alternative coating techniques, focusing on biomimetic deposition and the potential of Graphite for orthopedic implants due to its exceptional properties and porous microstructure. This porosity supports the growth of an apatite layer within the pores, creating a composite mimicking bone structure.

Graphite samples were immersed in simulated bodily fluid for 56 and 84 days for this study. SEM, EDS, and Vickers hardness tests were used to analyze the samples. SEM images of the samples immersed for 56 and 84 days show that the apatite layer formed spherical spheroids that agglomerated into clusters. Some apatite precipitated on the surface, creating small deposits across the sample. These deposits indicate the formation of an additional apatite layer. Voids were present, and within these voids, precipitation occurred, with some nucleation appearing as agglomerations of the apatite coating. EDS data indicated a high concentration of Ca, P, and O, which are dominant elements in hydroxyapatite and share properties with the bone. The data suggests that longer immersion periods enhance apatite layer growth. The ability of apatite to grow within graphite pores enhances its strength and imparts characteristics akin to bone-like material.

### References:

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# Department of Engineering and Physics

## Introduction

The Engineering and Physics Department is a collaborative and performance-driven community that offers engineering and physics programs. The department aims to identify and analyze local and global challenges and equip students with the skills and tools to solve these problems.

## The department consists of three units:

1. Agricultural Engineering
2. Electronic Engineering
3. Physics

## Mission

To contribute to sustainable development through continuous improvement of the quality of scientific research, teaching and learning process supported by the development of innovative curricula to match world trends in technological advancement.

## Core Values

1. Professionalism and integrity
2. Teamwork
3. Student-centredness

## Programmes on Offer:

BSc. Honours in Electronic Engineering (HBScEE)

BSc. Honours in Environmental Physics and Energy Sources (HBScEPES)

BSc. Honours in Agricultural Engineering (BSc.AE)

